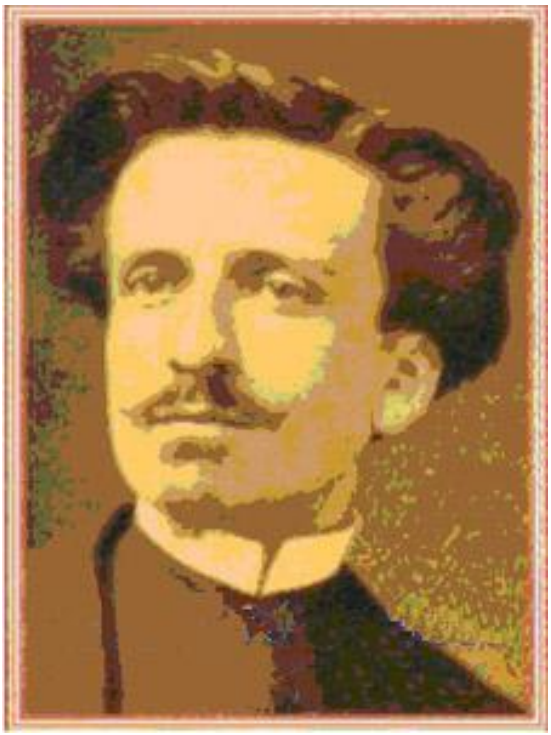
“Volcanic Phenomena in 1867”

by Doctor Gustave Le Bon

***(Les Curiosités Scientifiques de l’Année, 1867*, pages 115-119 – Paris: Charles Delagrave, 1868)**

Robert K. Stevenson – Translator and Editor

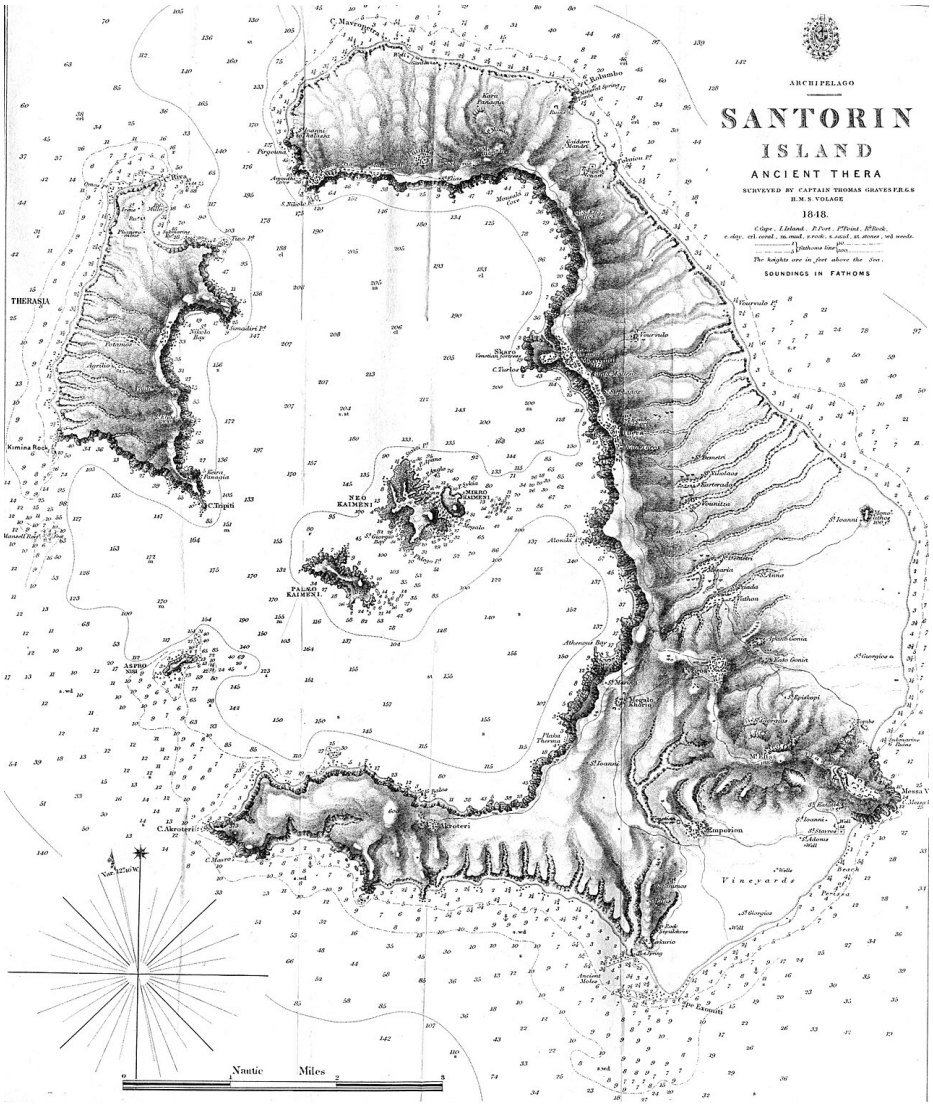


Gustave Le Bon in 1867; age 26

The English philosopher Hobbes maintained—not without a certain semblance of reason—that war is the natural state of man. He could also have added that it is the normal state of the elements that surround him and of the soil he treads beneath his feet.

For the past few years, indeed, the planet we inhabit has been shaken by violent tremors; islands have suddenly emerged, certain volcanoes have been almost constantly active, and earthquakes have been felt in many places.

Both last year and this year frequent volcanic phenomena have served to remind mankind just how fragile is the world it inhabits. Vesuvius has awakened from its long slumber. The Bay of Santorini has witnessed the emergence of new islands. In the Azores the ground was shaken by violent convulsions, and for several days the ocean shot out flames.



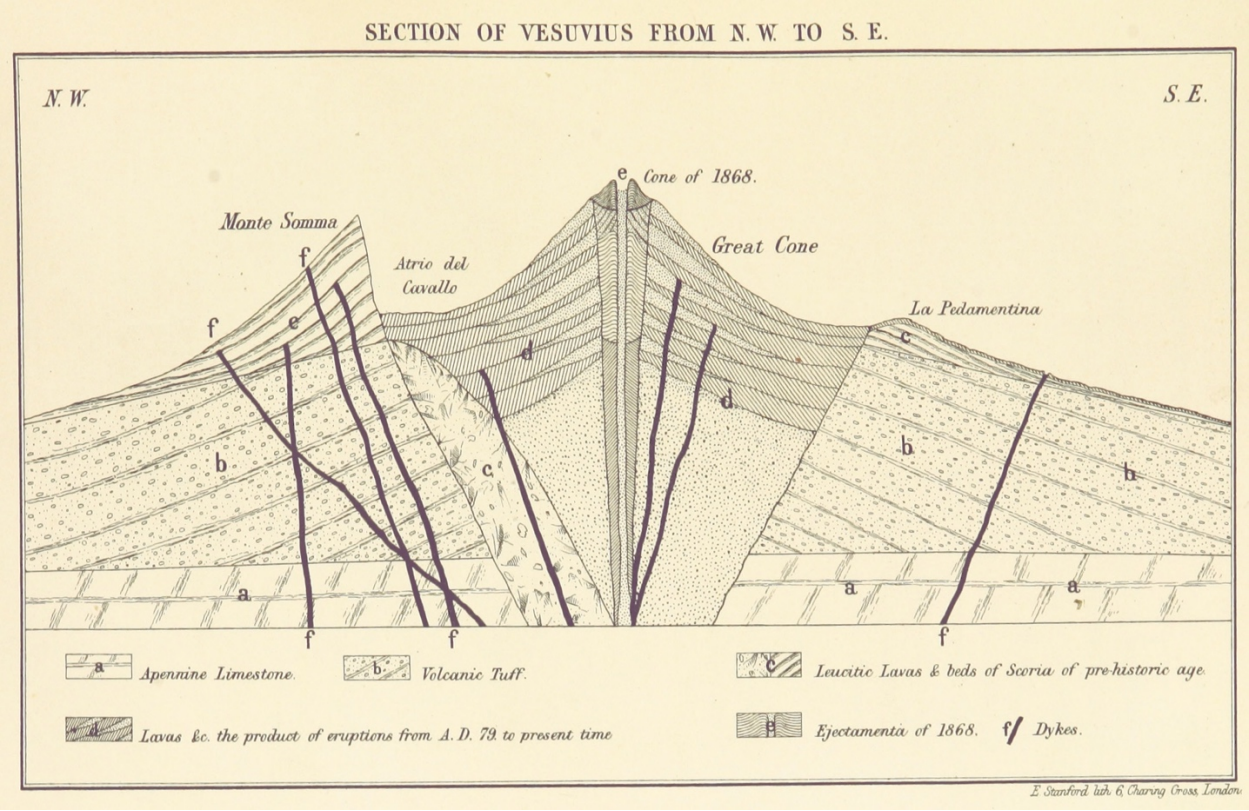
Map of Santorini as it appeared in 1848 and before new small islands emerged in 1866 in its bay

It was in the early days of 1866 that the inhabitants of Santorini witnessed a new island emerging from the depths of the waves. The harbor of Santorini is populated by small islands spewed forth by the sea—much like Santorini itself. Since the most remote antiquity, this region has been the scene of analogous phenomena. Pliny speaks of upheavals observed there in the year 19 AD, and since that time disturbances have been frequent.

The appearance of the new island was heralded by red flames, several meters high, rising from the sea. A few days later, the island slowly emerged and grew visibly before one's eyes. From its cone-shaped summit, stones and flames were incessantly hurled forth. In the days that followed, new islets continued to surface, eventually merging with one another. These new lands, which the waves seem to vomit out, are nothing other than the tops of volcanoes whose bases lie beneath the sea.

The volcanic phenomena we have just described recurred again this year, and several French scientists traveled to the site to examine them firsthand. By studying the flames of the volcanoes using that admirable method of investigation known as spectral analysis, Dr. Pierre Janssen, Professor of Physics at the École Spéciale d'Architecture in Paris, determined that hydrogen must be the basis of the combustible gases escaping from the crater. Furthermore, Professor Ferdinand Fouqué, a member of the French Academy of Sciences, analyzed them chemically and found them to have a rather varied composition. They contain, on average, 30 parts per 100 of hydrogen; the remainder consists of nitrogen and carbonic acid. The presence of hydrogen sulfide and hydrogen protocarbide was also observed there, in proportions that did not exceed 1 part per 100 for the former, and 3 parts per 100 for the latter. Plus, these gaseous mixtures contained a rather large quantity of water vapor rich in sulfuric and hydrochloric acids.

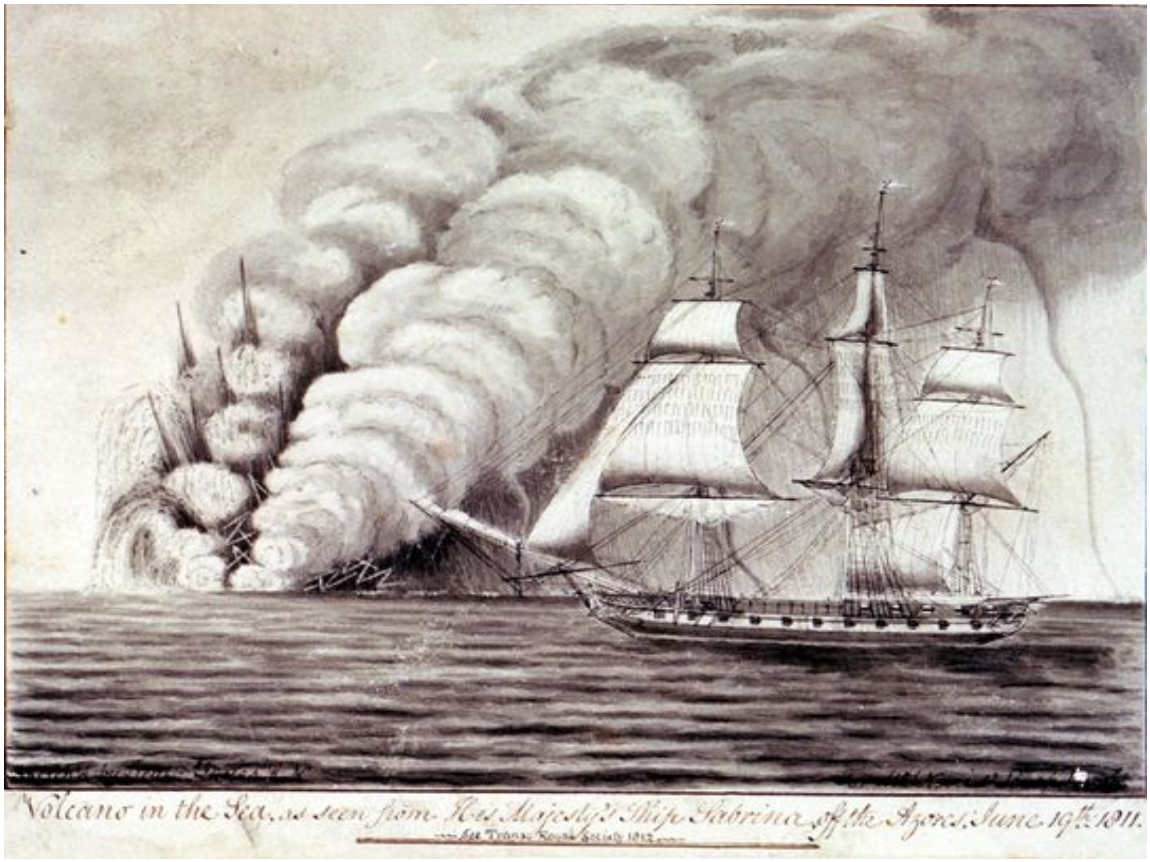
The volcanic phenomena that occurred at Vesuvius in 1867 had long been heralded by precursory signs. In 1858 and 1861, the volcano's activity appeared to be reawakening, but it was only in 1867 that the eruption manifested itself with violence. Frequent tremors shook the ground, and incandescent matter—lifting the enormous masses of lava that filled the ancient crater—was forcefully ejected outward. In June 1867 the circumference of the great crater measured 900 meters; it was lined with yellow, red and green iron chlorides, which peasants harvested to mix with flowers of sulfur—a mixture they subsequently sold to winegrowers to fertilize their vines.


SECTION OF VESUVIUS FROM N.W. TO S.E.
N.W.
S.E.
e Cone of 1868.
Monte Somma
Atrio del Cavallo
Great Cone
La Pedamentina
a Apennine Limestone.
b Volcanic Tuff.
c Leucitic Lavas & beds of Scoria of pre-historic age.
d Lavas &c. the product of eruptions from A.D. 79 to present time
e Ejectamenta of 1868. f Dykes.
E. Stanford lith. 6, Charing Cross, London

1868 Cross-section view of Vesuvius from the northwest to the southeast, showing the location of its lava beds and other important components

The spectacular submarine eruption, of which the Azores this year served as the theater, occurred on June 1st between the islands of Terceira and Graciosa. Since June 24, 1866 the ground had been shaken by frequent tremors. In the parish of Sarreta approximately 80 houses were destroyed. On June 1st an earthquake was felt that was even more violent than the preceding ones. Around ten o'clock that evening, detonations resembling artillery fire were heard, and the following days, the sea was seen to seethe and shoot jets of water to a great height. On June 4th it spewed forth stones. From six irregularly spaced points within an area of one league, jets of steam mingled with enormous stones rose to a great height. The phenomenon was accompanied by a sulfurous odor so strong that it was barely bearable from the coast. The eruption lasted seven days, then ceased. The ground tremors subsequently subsided, though without stopping entirely.

In order to fully understand the cause of these violent tremors that sometimes shake the ground, it is necessary to recall how the structure of the globe that we inhabit is constituted. Many millions of years ago, the Earth was an incandescent liquid mass. This mass cooled somewhat, and a solid crust formed upon its surface—a layer only about ten leagues thick—which constitutes its inhabited portion.



Drawing of the June-July, 1811 submarine eruption of Sabrina Island, located 2 kilometers west of Sao Miguel Island in the Azores. Sabrina Island reached a height of 100 meters, but disappeared from view after two months due to water erosion.

Beneath our feet lies an ocean of molten matter, approximately 1,500 leagues in diameter. When it strikes the thin crust that covers it, it shakes it, producing an earthquake. If the liquid mass is powerful enough to shatter the ground, it erupts outward and a volcano is formed.

According to the most recent theories, the force which agitates this formidable mass is the same as that which regularly raises the tides of the ocean. Everyone knows that the tides are the result of the attraction exerted upon the sea by the sun and the moon, and that they are particularly strong on days when these two celestial bodies are situated in such a position that they can combine their influence. The fluid mass filling the interior of our planet would therefore, like the sea, obey the gravitational forces exerted upon it. Indeed, it has been observed that earthquakes occur most frequently precisely during those times of the year corresponding to the strongest oceanic tides.

Relative to the total mass of the globe, the solid crust enveloping it is merely an extremely thin film. This film has frequently been convulsed by shocks from the sea of fire it overflies. Geology teaches us that the current configuration of the globe is, in part, due to its crust's action, and it is this very force that, only a few months ago, caused new islands to emerge from the ocean.

Earthquakes appear to be intimately linked to volcanic eruptions. Volcanoes are ever-open vents that, at certain moments, give passage to the liquid matter contained within the interior of the globe. Earthquakes, though, are extremely rare in France, and are of little consequence when compared to those that sometimes ravage Asia, the Americas, or Southern Europe. In a matter of seconds, populous cities are reduced to ruins, and thousands of inhabitants perish.

The earthquake that destroyed Lisbon about a century ago is one of the most terrible disasters recorded in history. On November 1, 1755—All Saints' Day—on a splendid morning, just as the inhabitants were flocking to the churches, a terrifying rumble was heard beneath the city. This rumbling was followed by three shocks. The first shook the houses, the second toppled them, and the third transformed the city into a vast heap of ruins. It was a horrifying spectacle, surpassing anything the imagination could conceive. In a few minutes 40,000 people perished.

18th Century copper engraving of terrified Lisbon residents during the city's horrific November 1, 1755 earthquake

As is most often the case, this terrible earthquake was followed by several others. It was noted that the column of smoke from Vesuvius vanished at the very moment Lisbon was destroyed. This fact appears to establish a connection between this earthquake and the tremors felt simultaneously in Italy.

In 1699, devastating shocks ravaged Calabria. The death toll reached 60,000. About a century later, Calabria and part of Sicily were once again devastated. The disaster struck at noon on February 5, 1783. The tremors were so violent that the ground heaved like ocean waves. They lasted only two minutes; but, in that brief span of time, three hundred towns or villages were leveled. Their foundations were torn up or scattered. The ground split open everywhere, swallowing those who had managed to escape. Some of the fissures were one league long; at times masses of water and steam spewed from them. Messina on Sicily's northeast coast was reduced to a heap of ruins. The death toll from this catastrophe was estimated to be 70,000.

Map showing the Kingdom of the Two Sicilies, particularly the places destroyed by the 1783 earthquake that struck Messina and surrounding areas

What a terrible power it is that thus, in a few moments, alters the face of our globe and transforms smiling lands into dismal ruins! How small man feels in the face of these awesome forces he cannot tame!

Generally, an underground noise precedes an earthquake. This sound is also heard while the ground shakes and buildings collapse. It results from the cracking and fracturing of the solid crust under the impact of the waves of fire striking it.

Ground tremors are most often vertical. The ground rises and subsides in succession. Sometimes the tremors are horizontal. Whenever they are both horizontal and vertical at the same time, nothing can withstand them.

The average duration of an earthquake varies enormously. The one that destroyed Caracas in 1812 lasted only three seconds. At other times, the shaking of the ground persists for weeks or even months. The tremors may follow one another in rapid succession, yet the duration of each individual shock is instantaneous.

Earthquakes never shake just a single point on the planet; they spread across vast areas. The earthquake that destroyed Lisbon shook an entire hemisphere. It was felt throughout Europe, in North Africa, and as far away as America. In addition, earthquakes do not merely topple cities. They alter the face of the globe, raising or lowering the ground and often transforming vast stretches of land into lakes.

The ground upon which Paris stands has been submerged several times. Indeed, layers containing the remains of both land and marine animals are found in the Parisian soil. For example, on the heights of Montmartre, one finds shells that the ocean deposited there long ago. There was a time when the sea covered the banks of the Seine; strange-looking creatures swam in its waters. They have vanished, and upon the very ground that witnessed so many cataclysms, the most brilliant of the world's capitals has risen. Are we, too, destined to disappear to make way for more perfect animals? Keep in mind that the Earth is unceasingly changing, and all evidence suggests that its current state of stability is merely apparent. Should the ocean of fire rumbling beneath our feet strike the fragile crust covering it with much violence, we, too, shall become numbered among the extinct races.

Skull of *Palaeotherium*, an extinct equine, found in 1825 on Montmartre in Paris

Note by the editor and translator, Robert K. Stevenson

Born on May 7, 1841 in Nogent-le-Rotrou, a prosperous farming community near Chartres, Gustave Le Bon enjoyed a long and extraordinarily productive life, dying halfway into his ninety-first year on December 13, 1931. His father and grandfather were both government functionaries. Having developed contempt for the type of work they did, Gustave spent six years of his young adulthood as a medical school intern in Paris, earning his license to practice medicine along with the title, "Doctor," a title that he used in identifying himself for the balance of his life.

During his time as a medical school intern, he authored two medical books—*La Brenne, Recherches sur la Fièvre Intermittante* (1862) and *De la mort Apparente et des Inhumations Prématurés* (1866). However, thirsting for social recognition, he decided to pivot away from writing medical texts and focused instead on establishing a career for himself as a synthesizer and popular writer on science, for which the broad-based scientific curriculum of his medical school days provided him a firm foundation.

The preceding paper, "Volcanic Phenomena in 1867," constitutes the first-ever work by Doctor Le Bon as a popularizer of science. Many, many more were to come, specifically 250 more papers and articles appearing in major periodicals. As an enthusiastic champion of scientism—that is, faith in science and the infallibility of the scientific method—Le Bon staunchly advocated for the application of the methods and terminology of the natural sciences to the social sciences. In fact, his most impactful and influential publications, such as his world-famous book, *The Crowd*, which dealt with and explained crowd psychology, fell into this latter group of sciences; and Le Bon himself came to be known as The Father of Social Psychology.

We see in Le Bon's above paper him trying to explain earthquakes and volcanic eruptions as occurring because of the Earth's crust being "convulsed by shocks from the sea of fire" underneath it, with gravitational forces of the moon and sun producing the shocks. The vastly more accurate explanation was theorized 45 years later and finally confirmed in the 1960s with the discovery of seafloor spreading that was evidenced by core samples drilled and retrieved from around the Mid-Atlantic Ridge. In 1912 German geophysicist Alfred Wegener presented in a paper titled "The Uplifting of Large Features of Earth's Crust on a Geophysical Basis" his theory of continental drift, which served as the foundational basis for the discovery that the Earth's crust is composed of seven major movable massive slabs called plates, such as the South American Plate and the Pacific Plate, along with 8-14 smaller plates. These plates move because intense heat from the planet's core drives circulation in the earth's mantle. This movement is therefore powered by thermal forces along with gravitational forces. In many instances two plates collide and get stuck. Over time stress builds up until the two plates suddenly slip, releasing a tremendous amount of stored energy, causing the ground to shake, sometimes extremely violently. In fact, the largest and most catastrophic earthquakes are those whose primary cause is the movement of two plates that have been pressed together for a considerable period of time.

Now, in the case of the 1755 Lisbon earthquake, it happens that located off Portugal's west coast are two major plates—the Eurasian Plate and the African Plate. The African Plate had for eons been pushing northward into the Eurasian Plate, and the slow, grinding convergence of these two plates ultimately produced in 1755 a massive rupture of an offshore thrust fault near Lisbon.

Alfred Wegener in 1912

With respect to the 1783 earthquake that killed tens of thousands of people in Messina and Calabria, once again the underlying cause was the northward movement of the African Plate into the Eurasian Plate. The immediate cause was the rupture of a series of active, shallow faults in what is called the Siculo-Calabrian rift zone.

As for why the Azores experiences so many submarine volcanic eruptions, it turns out that the Azores are not located along the intersection of two major tectonic plates, but rather three! Where these three plates—the African Plate, Eurasian Plate and North American Plate—come together is called the Azores Triple Junction. It is the African Plate-Eurasian Plate boundary which is the site of ongoing volcanic activity. In addition, a smaller plate called the Azores Microplate directly underlies this area, causing local intense hydrothermal and volcanic venting.

Turning to Santorini, unsurprisingly we see that the African Plate also plays a central role in the causation of its volcanic activity. This time the African Plate slips northward under the Aegean Microplate (part of the Eurasian Plate), generating intense heat and pressure, which eventually leads to the release of gases and lava.

Le Bon was 71 years old when Wegener's "The Uplifting of Large Features of Earth's Crust on a Geophysical Basis" paper appeared. We do not know if he was aware of this work, but, if so, because continental drift was just an unproven theory at the time, Le Bon could easily have reacted the way most geologists did, which was to express intense skepticism, if not outright hostility, to Wegener's idea; just as easily, though, Le Bon could have retained an open mind, given how often his own theories had been dismissed by other scientists. Wegener himself offered tidal forces and centrifugal forces as an explanation for what caused continental drift, but physicists easily proved that these two forces were way too weak to account for the movement of a continent. So, for lack of a mechanism the continental drift theory remained ignored for decades—until the 1960s when shockingly it was confirmed to be true, and Wegener became, long after his death in 1930, one of the Heroes of Science, an outcome Le Bon would have been one of the first to applaud.